

REMARKS

Claims 1, 3-6, and 10-12 are presently pending in the application.

Claim 1 has been amended to incorporate the subject matter from claims 2, 7, 8, and 9, which have been canceled. Claims 3-6 and 10 have been amended to correctly depend from claim 1. No new matter has been added by these amendments.

In Paper No 6, the Examiner has rejected claims 1-5, 7 and 10-12 under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,700,596 of Ikoma et al. ("Ikoma") in view of JP 07-094182 ("JP '182"). Claims 1, 3-5, 7 and 10-12 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over Ikoma in view of JP '182 and further in view of JP 11-238509 ("JP '509"). Further, claims 5-6 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over Ikoma in view of JP '182 and JP '509 and further in view of JP 11-149924 ("JP '924"). Finally, claims 8-9 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over Ikoma in view of JP '182 and JP '509 and further in view of JP 11-219703 ("JP '703"). Applicants respectfully traverse these rejections and the arguments in support thereof as follows, and respectfully request reconsideration and withdrawal of the rejections.

Rejection Under § 103(a) Based on Ikoma in view of JP '182

The Examiner argues that Ikoma teaches a positive electrode active material for an alkaline storage battery comprising a nickel hydroxide powder solid solution containing magnesium in 1-7 weight percent (about 3.9-27 mole percent based on $\text{Ni}(\text{OH})_2$ and Mg). Nickel hydroxide allegedly has a tap density of 1.9 g/cm³ or more. The Examiner acknowledges that Ikoma does not disclose a sulfate ion content for a magnesium doped nickel hydroxide. Mixtures of other elements, including cobalt and manganese, are noted. The active material is

allegedly mixed with cobalt powders and cobalt hydroxide to form a positive electrode. The Examiner acknowledges that Ikoma is silent as to the X-ray diffraction measurements of the material.

However, JP '182 allegedly teaches a nickel hydroxide material which has a half-width of a (101) peak near $2\theta = 37-40^\circ$ in a powder x-ray diffraction pattern by CuK α radiation in the range of 0.7 to 1.2° and a ratio of A_{001} to B_{101} greater than 1.1. The Examiner concludes that it would have been obvious to one of ordinary skill in the art at the time of the invention to use a nickel hydroxide material with these crystal features in the alkaline battery of Ikoma as JP '182 teaches that the material enhances active material utilization at high temperature and increases discharge capacity in alkaline batteries.

The Examiner further argues that the cited references teach the use of an alkaline electrolyte without specifically mentioning sodium hydroxide. However, the Examiner contends that since sodium hydroxide is well known in the art to transfer ions in an alkaline battery, it would have been obvious to one having ordinary skill in the art at the time of the invention to incorporate 1-5 M electrolyte of sodium hydroxide into an alkaline battery. Further, one of ordinary skill in the would have had the motivation to choose sodium hydroxide as the electrolyte material since the sodium ion is sufficiently small to transfer charge and the hydroxide group is an alkaline material. Applicants respectfully traverse this rejection as follows.

The present invention is directed to a positive electrode for an alkaline storage battery containing an active material comprising a nickel hydroxide powder solid solution with specific properties. Namely, the nickel hydroxide contains 2-7 mol % magnesium based on all of the metallic elements contained in the nickel hydroxide, a tap density of 1.9 g/cm^3 or more,

and a sulfate ion content of 0.5 weight percent or less. Further, the nickel hydroxide material has a half width of a (101) peak near $2\theta = 37-40^\circ$ in a powder x-ray diffraction pattern by CuK α -radiation of $0.7-1.2^\circ$ and a B/A ratio (the ratio of the intensities of the (001) to the (101) peaks) of 1.1 or more. Further, the positive electrode contains 0.5 to 3 parts by weight of an oxide of at least one element selected from Y, Yb, Lu, Ti, and Ca ("Group Y oxides"). The specific properties of the nickel hydroxide are critical to yielding an active material with high discharge voltage and excellent high rate discharge characteristics.

For example, the addition of Mg decreases the charge efficiency at high temperatures. Similarly, inclusion of even very small amounts of sulfate ion also decreases the charge efficiency at high temperatures. Furthermore, as shown in Figs. 4 and 10 of the present application, when the B/A ratio is at least 1.1, the active material utilization rate increases.

Inclusion of a Group Y oxide also has a significant effect on the charge efficiency at high temperature. As shown in Table 1, which compares batteries A-E (which contain an oxide of Y, Yb, Lu, Ti, or Ca) and F (which does not contain a Group Y oxide), it can be seen that inclusion of the group Y oxide is effective in improving charge efficiency at high temperatures.

All of the claimed elements are not taught or suggested by the proposed combination of Ikoma and JP '182 as follows. First, it is noted that the X-ray diffraction characteristics taught by JP '182 are not similar to those of the present invention because they do not describe a nickel hydroxide solid solution containing Mg. Instead, the active materials taught by JP '182 contain a solid solution which contains Mn. This difference is significant because the preferred range of the X-ray diffraction characteristics of a material varies significantly depending on the presence or absence of an additional element in the material and the type of the

element. For example, in the case of a nickel hydroxide solid solution containing Mn, the (001)/(101) peak ratio (B/A) is preferably smaller than that for a nickel hydroxide solid solution containing Mg. Accordingly, one reading Ikoma (which is directed to nickel hydroxide containing Mg) would not look to the nickel hydroxide of JP '182 (which contains Mn instead of Mg). Further, even if the proposed combination of references were valid, it would not result in the claimed invention, since the X-ray diffraction characteristics are not for the same material.

Additionally, as acknowledged by the Examiner, neither Ikoma nor JP '182 teaches a positive electrode containing an oxide of Y, Yb, Lu, Ti, or Ca, nor the claimed sulfate ion content of 0.5 weight % or less. For all of these reasons, the present claims would not have been obvious based on the proposed combination of these references and no *prima facie* case of obviousness has been established based on the proposed combination of Ikoma and JP '182. Reconsideration and withdrawal of the § 103(a) rejection are respectfully requested.

Rejection Under § 103(a) Based on Ikoma in View of JP '182 and Further in View of JP '509

The Examiner argues that while the proposed combination of Ikoma and JP '182 does not disclose a sulfate ion content for a magnesium doped nickel hydroxide, it is considered to be zero, and the prior art allegedly teaches that lowering the sulfate radical in a nickel electrode will improve capacity and prolong battery life. Further, the Examiner contends that JP '509 teaches a nickel oxide active material that contains an element such as Mg, Co, Zn dissolved as a solid. The amount of the sulfuric acid radical (sulfate) is set to be less than 0.4 weight percent. Therefore, the Examiner concludes that it would have been obvious to one of ordinary skill in the art at the time of the invention to alter the amount of sulfate to be less than

0.4 weight percent in order to improve capacity and prolong battery life. Applicants respectfully traverse this rejection as follows.

As previously explained, neither Ikoma nor JP '182 teaches or suggests inclusion of 0.5 to 3 parts by weight of an oxide of Y, Yb, Lu, Ti or Ca in the positive electrode, and JP '509 does not cure this deficiency. Furthermore, JP '509 does not teach the claimed X-ray diffraction properties for a Mg-containing nickel hydroxide. Therefore, even the proposed combination of Ikoma, JP '182 and JP '509 does not teach or suggest all of the claimed elements, and reconsideration and withdrawal of the § 103(a) rejection are respectfully requested.

Rejection Under § 103(a) Based on Ikoma In View of JP 182, JP '509, and JP '924

Regarding claim 5, the Examiner argues that the references teach mixing the active material with cobalt hydroxide, which is an oxide of cobalt. The Examiner acknowledges that the cited references do not teach the average valence number of cobalt in the cobalt oxide material to be larger than 3.

However, JP '924 allegedly teaches an alkaline storage battery with improved energy density and cycle life in which a nickel hydroxide solid particle is coated with a layer of cobalt oxide material having a valence of 3 or higher to form a positive electrode active material. The nickel hydroxide material allegedly has a half-width of a (101) peak near $2\theta = 37-40^\circ$ in a powder x-ray diffraction pattern by CuK α -radiation in the range of $0.7-1.2^\circ$ and a ratio of A_{001} to B_{101} such that A/B is greater than 1.1. The Examiner concludes that it would have been obvious to one having ordinary skill in the art at the time of the invention to incorporate a nickel hydroxide solid particle coated with a layer of cobalt oxide material having a valence of 3 or higher to form a positive electrode active material in the nickel hydroxide electrodes of Ikoma,

since a coating layer of cobalt oxide material is shown to improve energy density and cycle life in the battery. Applicants respectfully traverse this rejection as follows.

First, it is noted that the X-ray diffraction characteristics taught by JP '924 are not similar to those of the present invention in that, like JP '182, they relate to a nickel hydroxide containing Mn rather than Mg. Accordingly, there would be no motivation to combine Ikoma (in which the nickel hydroxide contains Mg) with JP '924 for X-ray characteristics of the nickel hydroxide. Even if the proposed combination were valid, JP '924 would not cure the deficiencies in the proposed combination of references since neither X-ray characteristics of Mg-containing nickel hydroxide nor inclusion of a Group Y oxide in the electrode is taught or suggested by JP '924. Therefore, since even the proposed combination of Ikoma, JP '182, JP '509 and JP '924 would not teach or suggest all of the claimed elements, reconsideration and withdrawal of the § 103(a) rejection are respectfully requested.

Rejection Under § 103(a) Based on Ikoma in view of JP '182, JP '509, JP '924 and JP '703

Regarding claims 8-9 (present claim 1), the Examiner acknowledges that none of Ikoma, JP '182, JP '509, and JP '924 teaches adding an oxide powder material of Y, Yb, Lu, Ti or Ca to the mix in 0.5-3 parts by weight to the active material. However, JP '703 allegedly teaches an alkaline storage battery with high use coefficient in which a nickel hydroxide/magnesium solid solution is mixed with 0.5-5% of an yttrium oxide material to form a positive electrode. The Examiner thus concludes that it would have been obvious to one having ordinary skill in the art at the time of the invention to add yttrium oxide to a nickel hydroxide-magnesium solid solution in the electrode of the prior art since the addition of this material is shown to produce a high utilization factor over a long period of time from the early stages of the

charge/discharge cycle and also raises the capacity of the alkaline battery. Applicants respectfully traverse this rejection as follows.

JP '703 is directed to improving active material utilization ratios at room temperature by combining a nickel hydroxide solid solution containing Mg and a group Y oxide. However, JP '703 is silent about a sulfate ion concentration and there is thus no way to predict based on JP '703 the effect of the group Y oxide on a very small amount of sulfate ion.

On the other hand, JP '509 is directed to improving the active material utilization ratios at high temperatures and prolonging battery life. For these purposes, the sulfate ion content in the nickel hydroxide solid solution containing Mg is limited to 0.4 weight % or less. However, since JP '509 is silent as to the group Y oxide, it is also impossible to predict based on JP '509 the effect of the group Y oxide on the very small amount of sulfate ion. Further, JP '509 does not teach or suggest the challenge of improving charge efficiency at high temperature.

Accordingly, since JP '703 and JP '509 have different objectives, one skilled in the art would not have been motivated to make the proposed combination of references. However, even if the proposed combination were valid, the present invention demonstrates results which would not have been expected based on this combination. Specifically, Applicants have discovered that deterioration in charge efficiency at high temperatures may be inhibited by including a very small amount of sulfate ion in the nickel hydroxide and by including a group Y oxide in the electrode. As can be seen by comparing Figures 3 and 9 of the present application, the battery containing the group Y oxide (shown in Figure 9) exhibits higher utilization ratio in the range where the sulfate ion concentration is low, indicating that the group Y oxide is effective on the very small amount of sulfate ion. However, if the sulfate ion content is too large (exceeding 0.5 weight %), the group Y oxide is not effective. The importance and criticality of

Application No. 10/040,184
Reply to Office Action of December 1, 2003

the amount of sulfate ion, in conjunction with the Group Y oxide, are not taught or suggested by any of the cited references, alone or in combination, and would not be expected since JP '703 only teaches that the Group Y oxide is effective on Mg, and JP '509 does not teach the Group Y oxide at all. The unexpected results exhibited by the present invention would thus overcome any *prima facie* case of obviousness, were one to be established, and reconsideration and withdrawal of the § 103(a) rejections are respectfully requested.

Based on the preceding Amendments and Remarks, it is respectfully submitted that the pending claims are patentably distinct over the prior art of record and in condition for allowance. A Notice of Allowance is respectfully requested.

Respectfully submitted,

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